

Section 7 Summary of Site Risks

Risk assessments have been conducted in Butte since the early 1990s to quantify actual and potential human health and environmental risks from chemical contaminants in tailings, waste rock, soils, indoor dust, surface water and groundwater. The baseline risk assessment estimates what risks the site poses if no action were taken and identifies the contaminants and exposure pathways that need to be addressed by the remedial action.

Previous response actions have greatly reduced site risks. Nevertheless, contamination remaining on-site still presents unacceptable risks to human and ecological receptors. The Selected Remedy is necessary to protect public health or welfare or the environment from actual or threatened releases of these and other contaminants to the environment. The COCs at the BPSOU, by media, are shown in Table 7-1. The key COCs at the site are arsenic, cadmium, copper, lead, mercury, and zinc.

Table 7-1
Summary of Chemicals of Concern for the BPSOU
Record of Decision
Butte Priority Soils Operable Unit
Silver Bow Creek/Butte Area NPL Site

Chemical	Solid Media	Groundwater	Surface Water
Aluminum			X
Arsenic	X	X	X
Cadmium		X	X
Copper		X	X
Iron			X
Lead	X	X	X
Mercury	X	X	X
Silver			X
Zinc		X	X

7.1 Human Health Risks

The primary sources of BPSOU site contaminants are mining, milling, smelting and ore processing wastes, which include waste rock piles, milling and concentrator wastes, and smelting wastes. The primary routes of movement of these contaminants are runoff, infiltration, percolation, and wind erosion. Contaminant movement can also occur from secondary sources: surface soils to surface water by runoff; transport to groundwater through leaching, infiltration, and percolation; and contaminated dust to other media through wind erosion.

Regarding human health risks, the exposure pathways of concern for contaminants at the BPSOU are ingestion of soils and dust, direct contact with skin, and ingestion of water. Depending upon the characteristics of the contamination and the population, some pathways are more important than others. All primary and secondary transport

pathways were reviewed in accordance with the EPA risk assessment guidance and procedures, and those that were complete and presented a risk to human health were evaluated quantitatively. The Selected Remedy is intended to prevent or mitigate exposure pathways through appropriate excavation and removal (especially in yards and attics), capping, land reclamation, institutional controls, storm water controls, and groundwater control and treatment. Another major purpose of the Selected Remedy is to maintain and monitor the remedy to ensure that exposure pathways are prevented or mitigated.

For humans, the primary exposure pathways at the OU are:

- Ingestion of surface soils (for residents, commercial workers, and railroad workers);
- Ingestion of interior dust (for residents and commercial workers);
- Dermal exposure to surface water (for recreational visitors);
- Ingestion of surface water (for recreational visitors); and
- Ingestion of alluvial groundwater risks were calculated, although no current exposures occur.

Only one significant secondary exposure pathway for humans was identified: inhalation of fugitive dust (for residents, commercial workers, railroad workers, and recreational visitors).

The Preliminary Baseline Risk Assessment ([PBRA], Clement 1991) used data collected from the Butte Soil Screening Study (CDM 1988) to identify contaminants present in the BPSOU that posed significant human health risks. The PBRA concluded that arsenic and lead could pose a risk to human health at the BPSOU site. The PBRA ruled out further assessment of exposure to cadmium. Mercury was generally not evaluated because many mercury source areas discovered in Walkerville had been addressed, and the study assumed any future discovery of mercury would be similarly addressed. Therefore, EPA conducted subsequent human health risk assessments focused on arsenic and lead exposure scenarios within the BPSOU. These assessments were:

- The Preliminary Baseline Human Health Risk Assessment for Lower Area One (CDM, 1991);
- Baseline Human Health Risk Assessment for Lead (CDM 1994) and Enforcement/ Action Memorandum – Butte Priority Soils Operable Unit (EPA 1994);
- Baseline Human Health Risk Assessment for Arsenic (CDM 1997) and Enforcement/ Action Memorandum - Railroad Bed Time Critical Removal Action Attachment A: Arsenic Action Levels (EPA 1999a);

- Technical Memorandum: Addendum to the Baseline Human Health Risk Assessment; Evaluation of Human Health Risks Associated with Exposure to Alluvial Ground Water - Butte Priority Soils Operable Unit (CDM 2001a); and
- Human Health Risk Assessment, Walkerville Residential Site (UOS 2003).

Major findings of each of these assessments are discussed below.

7.1.1 Preliminary Baseline Human Health Risk Assessment for Lower Area One

The Final Preliminary BRA for LAO was completed in 1991. The risk assessment evaluated human health and ecological risks associated with inorganic contaminants in groundwater and surface water for the LAO portion of the BPSOU. The objective of the human health portion of the LAO risk assessment was to evaluate the potential effects of contaminated surface water and/or groundwater from LAO for human receptors. The final list of COCs based on concentrations, frequency of detection, and toxicity were arsenic, cadmium, chromium, lead, and zinc.

Based on current and future land-use at LAO, several human exposure scenarios for both surface water and groundwater were evaluated during the LAO risk assessment including occupational, recreational (swimming, inner-tubing), trespassing, and residential scenarios. The assessment quantitatively characterized the potential carcinogenic risk and noncarcinogenic health impacts from exposure to COCs in both groundwater and surface water within LAO. Risks to human receptors from exposure to COCs in surface water were determined to be low and negligible in comparison to the risks associated with exposure to COCs from daily ingestion of groundwater. Based on a future residential scenario, where groundwater in the alluvial aquifer beneath LAO would be consumed daily over a lifetime (70 years), unacceptable carcinogenic risk was determined from exposure to arsenic and unacceptable non-carcinogenic risk was determined from exposure to arsenic, cadmium, and zinc. Also, lead in groundwater presented a potential concern because it was determined that daily ingestion of lead concentrations in groundwater at LAO may result in blood lead levels above 10 micrograms per deciliter ($\mu\text{g}/\text{dL}$). Exposure to COCs in surface water and groundwater from non-residential exposure scenarios were determined not to pose a human health risk.

7.1.2 Baseline Human Health Risk Assessment for Lead

The BRA for lead, completed in 1994, was conducted to evaluate potential human health risks associated with exposure to lead within residential areas of the BPSOU (CDM 1994). Potential human health risks were predicted using EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead to predict blood lead levels from environmental exposure to lead.

The Preliminary RGs for lead were developed according to EPA's Risk Assessment Guidance for Superfund. Site-specific inputs were used for lead in soil, house dust, and the bioavailability of lead in soil. A bioavailability of 10 percent was used for soil

and indoor dust, respectively, based on bioavailability studies in both monkeys and swine. The remainder of the risk equation input variables were default values recommended by EPA guidance and the EPA toxicologist to define the reasonably maximum exposed individual. Based upon the IEUBK Lead Model developed for the BRA for Lead, EPA derived a preliminary remedial goal of 1,200 mg/kg for residential soils and a preliminary RG of 2,300 mg/kg for non-residential soils to maintain a blood-lead level of 10 µg/dL or less for at least 95 percent of the children between the ages of zero and 6 years, which is within EPA targeted risk range. The Preliminary RGs for the cleanup of lead contaminated soils in residential and non-residential areas within the BPSOU were mandated and published in the Priority Soils NTCRA action memorandum and Proposed Plan.

7.1.3 Baseline Human Health Risk Assessment for Arsenic

The BRA for arsenic was completed in 1997 to evaluate potential human health risks associated with exposure to arsenic in residential areas of the BPSOU. As a known carcinogen, arsenic may pose both cancer risks and non-cancer risks. The Preliminary RGs for arsenic were developed according to EPA's Risk Assessment Guidance for Superfund. Site-specific inputs were used for arsenic in soil and house dust, and the bioavailability of arsenic in soil. Bioavailability of 18 and 25 percent were used for soil and indoor dust, respectively, based on bioavailability studies in both monkeys and swine. The remainder of the risk equation input variables were default values recommended by EPA guidance and the EPA toxicologist to define the reasonably maximum exposed individual. Preliminary RGs were calculated representing cancer risks of 1 in 10,000, 1 in 100,000 and 1 in 1,000,000. Under the reasonable maximum exposure scenario, the selected Preliminary RG of 250 mg/kg represents a 1 in 19,040 cancer risk, which is within EPA targeted risk range.

7.1.4 Technical Memorandum: Addendum to the Baseline Human Health Risk Assessment; Evaluation of Human Health Risks Associated with Exposure to Alluvial Ground Water

Neither the BRA for Lead nor the BRA for Arsenic evaluated human health risks from exposure to contaminated groundwater at the BPSOU. This was because groundwater data representative of current site conditions were not available at the time these risk assessments were conducted. The LAO risk assessment did present conclusions regarding risks associated with ingestion of alluvial groundwater beneath LAO. However, this evaluation was limited to the LAO area and, more importantly, was conducted with data collected before the LAO removal and other removal actions at the BPSOU were complete. Therefore, when groundwater data more indicative of the current site conditions were collected, EPA determined that the potential human health risks associated with exposure to alluvial groundwater at the BPSOU should be assessed.

Based on hydrogeologic considerations, including the spatial extent of the alluvial aquifer, potential sources of contaminants, groundwater flow characteristics (flow direction and flow boundaries), and groundwater quality, the BPSOU was divided

into nine separate groundwater exposure units. Risk calculations were performed for each groundwater exposure unit independently.

Non-cancer risks (systemic risks) from ingestion of alluvial groundwater were found to be location and element specific. Blood lead levels in children would be unacceptable if groundwater in Lower Area One and Metro Storm Drain was ingested.

The risk assessment of the alluvial groundwater throughout the OU shows that cancer risks are driven by arsenic concentrations in groundwater and are unacceptable in major portions of Butte (Buffalo Gulch, West Side, Railroad Yards, Lower Area One, and the Metro Storm Drain exposure units), if actual exposure should occur.

7.1.5 Human Health Risk Assessment, Walkerville Residential Site

In 2001, EPA performed a supplemental risk assessment to determine whether arsenic, lead, and mercury in outdoor soil and indoor dust presented an unacceptable health risk to children and adults living in Walkerville (UOS 2003). The Walkerville risk assessment was implemented to address concerns raised by the public regarding mercury contamination in Walkerville. Prior EPA risk assessments addressed arsenic and lead risks, which are the primary drivers of the residential cleanups.

The soils in residential yards, soil in earthen basements, and dust in living areas and attics of Walkerville were found to be sources of arsenic, lead, and mercury. In general, concentrations of these metals were highest in attic dust or basement soil, lower in outdoor soil, and lowest in indoor living area dust.

The risk assessment showed that lead in outdoor soil and indoor dust at Walkerville residences pose an unacceptable health risk to young children. Non-cancer risks for arsenic and (generally) mercury in outdoor soil and indoor dust are at acceptable levels.

The attic-use survey conducted by EPA in consultation with the Agency for Toxic Substances Disease Registry (ATSDR) concluded that, under normal conditions, people using their attics have a complete exposure pathway. The surveys and risk assessment show the frequency of attic use is very low and the risks are within EPA's acceptable risk range. The study found that home occupants suffer limited exposure to attic dust because they access attics on a limited basis and are exposed for a short duration. Using the survey finding, the risk assessment concluded that contaminants in attic dust do not generally pose unacceptable risk to occupants because a complete exposure pathway does not exist. In the event that a complete exposure pathway is created by activities such as remodeling or when an avenue of exposure is created by ceiling or wall deterioration, an unacceptable risk may occur.

Based on the results of the Walkerville risk assessment, EPA established an indoor residential action level for mercury vapor of 0.43 $\mu\text{g}/\text{m}^3$ and an action level of 147 mg/kg for mercury in residential soil. The previously established residential action

levels for arsenic (250 mg/kg) and lead (1,200 mg/kg) in soils were determined to be protective.

7.2 Ecological Risk

BPSOU is in an urban setting with limited natural terrestrial habitat. Due to the limited terrestrial habitat, risks to terrestrial ecological receptors were not determined. Aquatic habitat occurs along Silver Bow Creek, in adjacent wetland areas, and in surface water ponds used to control sediments. These aquatic environments are habitat for invertebrates, fish, waterfowl and other biota. Therefore, assessments of ecological risk in the BPSOU focused on aquatic environments.

Two ecological risk assessments have been conducted at the BPSOU:

- Preliminary Baseline Risk Assessment (PBRA) for the Lower Area One (LAO) Non-Time Critical Removal Action (N-TCRA) (CDM 1991); and
- Final Baseline Ecological Risk Assessment (BERA), Silver Bow Creek/Butte Area NPL Site, Butte Priority Soils Operable Unit (CDM 2001b).

The ecological portion of the PBRA focused of risks to ecological receptors inhabiting the portion of Silver Bow Creek within the BPSOU. This area is consistent with the area of primary ecological concern at the OU. The PBRA included:

- Identification of ecological site COCs
- Discussion of fate and transport mechanisms, site receptors, and exposure pathways
- Preliminary identification of assessment and measurement endpoints
- Evaluation of ecotoxicological effects and potential risks to aquatic receptors, using conservative toxicity values

Since the PBRA was conducted in 1991, numerous response action activities have been conducted at the BPSOU, including:

- Removal of tailings and other contaminated solid media from the Silver Bow Creek floodplain in LAO
- Reconstruction of the Silver Bow Creek channel through LAO
- Removal of arsenic and lead contaminated mine waste on the Butte Hill
- Construction of engineered caps over contaminated mine waste on the Butte Hill
- Residential yard replacement

- Land reclamation
- Construction of storm water controls

These response actions resulted in the removal or control of some sources of environmental contamination to Silver Bow Creek and have reduced the level of contaminants in the creek. Because the response actions altered the environmental conditions in Silver Bow Creek, ecological risks characterized in the PBRA were no longer representative of site conditions. As a result, EPA determined that further risk characterization was needed to determine the level of ecological risks (actual or potential) to aquatic receptors that continue to exist under current site conditions. The Ecological Technical Assistance Group (ETAG) for the BPSOU determined that the PBRA satisfied the requirements of the Screening-Level Ecological Risk Assessment (SERA) and, therefore, represented the initial two steps of the eight-step ecological risk assessment process for Superfund. The PBRA documents the presence of environmental risks associated with exposure to specific contaminants in wastes in the Silver Bow Creek floodplain and was a key factor in EPA's decision to take a response action at LAO.

Due to the urban setting at the BPSOU, terrestrial habitat is limited to non-existent. For this reason, EPA determined that terrestrial receptors would not be evaluated and focused the risk characterization on the aquatic environment. Animals in the aquatic environment may be exposed to toxic levels of contamination in the following ways:

- Fish and benthic macroinvertebrates may be exposed by breathing or touching surface water and sediment and by ingestion of prey or sediment.
- Waterfowl may be exposed by direct ingestion of surface water and sediments or by ingestion of contaminated prey.

To determine the level of current ecological risks in Silver Bow Creek, EPA initiated the BERA to evaluate risks to aquatic receptors in the creek from its origin at the confluence of Metro Storm Drain and Blacktail Creek to the Butte Metro Sewer discharge at the downstream (western) extent of the BPSOU. Also, the BERA evaluated risks to waterfowl in on-site ponds that were created during the removal of waste material in LAO. The BERA constituted the remaining six steps of the eight-step ecological risk assessment process for Superfund recommended by current EPA guidance.

The BERA was designed to quantify risks to ecological receptors under the current site conditions to determine the need for further remedial action. It included:

- Documentation of any risks to aquatic receptors from exposure to arsenic or metals that may continue in Silver Bow Creek (within the BPSOU) after the implementation of source area removals, assuming continued input of site contaminants to Silver Bow Creek from groundwater and surface water discharge.

- Identification of site contaminants that continue to pose ecological risks to aquatic receptors.
- Generation of information for making risk management decisions and evaluating remedial alternatives.

One of the RGs for the BPSOU site is to return the reach of Silver Bow Creek within the BPSOU to its beneficial uses, which include supporting a self-sustaining trout fishery. This implies that arsenic and metals concentrations and other chemical components in surface water and sediments cannot pose adverse effects to any life stage of fish, including the more sensitive larval and early fry stages, and the important prey species consumed by trout, such as benthic macroinvertebrates. To ensure that this remedial goal can be achieved, EPA identified additional management goals, beyond the main goal of assessing current ecological risk, for the BERA:

- Determine levels of contaminants that will allow a self-sustaining salmonid fishery in Silver Bow Creek, specifically, the establishment of brook trout and other fish species currently present in Blacktail Creek; and
- Determine levels of contaminants that will allow survival of salmonid species.

Primary contributors to ecological risk, based on the BERA evaluations, are identified as “major COCs”. They are:

- Surface water - cadmium, copper, manganese, and zinc
- Sediment - arsenic, cadmium, copper, lead, and zinc
- Waterfowl exposures - copper and zinc

Despite the response actions taken at LAO to remove wastes from the Silver Bow Creek floodplain and to minimize the impacts from contaminated groundwater, the risk characterization determined that hazard quotients (HQ) greater than 1 are still evident for both surface water and sediment within Silver Bow Creek. HQs greater than 1 indicate unacceptable environmental risks under EPA’s ecological risk assessment guidance. The risk characterization showed that the most hazardous ecological conditions at the BPSOU are in the tributary drainages to Silver Bow Creek (e.g., Missoula Gulch and Metro Storm Drain), which suggests that ecological conditions could still be improved with further remedial action.

Risk questions defined in the BERA are repeated below, along with responses, to summarize the results of the risk assessment.

- *Are levels of mining-related contaminants in surface water and sediment sufficiently elevated to adversely affect survival, growth, or reproduction of salmonid fish in Silver Bow Creek?* Yes. Salmonid fish are at risk from metals-contaminated surface water and sediment. Survival, growth, and reproduction are likely to be impaired at the most contaminated

locations. Although not quantitatively assessed, metals-contaminated sediments and prey are also expected to contribute to the overall risks to salmonid fish.

- *Are levels of mining-related contaminants in surface water and sediment sufficiently elevated to adversely affect the survival, growth, and reproduction of aquatic plants and aquatic invertebrates in Silver Bow Creek?* Yes. Sensitive aquatic invertebrates and some forms of aquatic plants are at risk from contamination of surface water and sediments.
- *Are the levels of mining-related contaminants in surface water, sediments, aquatic vegetation, and aquatic invertebrates sufficiently elevated to adversely affect the survival, growth, and reproduction of waterfowl frequenting Missoula Gulch Ponds and LAO Ponds?* Waterfowl may be at significant risk due to cadmium, copper, and zinc via ingestion of metals-contaminated sediments and food. Elevated risk estimates are directly related to assumptions on diet, foraging frequency, and COC concentrations. Risks are probably over-estimated because of conservative assumptions used where site-specific data are lacking. Contaminated pond surface water may also be of concern, mostly due to bioaccumulation potential rather than direct ingestion.

7.3 Remaining Risk

Although the previous response actions and the residential lead abatement program have reduced human health risks, metal-laden mine waste within the BPSOU continues to threaten human health and the environment, and continues to adversely impact local groundwater and surface water resources. As a result, the Selected Remedy builds upon the accomplishments of previous response actions to eliminate or mitigate remaining human and ecological risks.

The Selected Remedy includes, but is not limited to, the following major critical elements to address remaining risks:

- A site-wide operations and maintenance program for reclaimed sites to ensure permanence of the caps over mine waste.
- Alluvial groundwater collection and treatment along with appropriate institutional controls, ARAR waivers, and monitoring.
- Additional source removal, capping of mine waste and land reclamation for contaminated solid media.
- Plans for a Residential Metals Abatement Program that takes a multi-pathway approach to addressing arsenic, lead, and mercury in yards and homes. All residential properties will be sampled within the BPSOU with remediation when indicated.
- A phased storm water management program combining initial action, aggressive monitoring, source area stabilization, and engineering controls to minimize impacts from storm water runoff and return Silver Bow Creek to its beneficial uses.

- Elevated arsenic and metals occur in stream-bed and bank sediments in Silver Bow Creek at concentrations that present significant risks to aquatic biota. These sediments are most notable within the slag canyon west of Montana Street and within the upper reaches of the Silver Bow Creek channel in Lower Area One and the lower reach of Blacktail Creek. The Selected Remedy will remove contaminated sediments from the stream channel bottom and stream banks, and adjacent floodplain from above the confluence through the slag canyon to the reconstructed floodplain in Lower Area One.

7.4 Basis of Action

The response actions selected in this ROD are necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.